Diclofop-methyl

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Guideline

The maximum acceptable concentration (MAC) for diclofop-methyl in drinking water is 0.009 mg/L (9 μ g/L).

Identity, Use and Sources in the Environment

Diclofop-methyl is a chlorophenoxy derivative used in large quantities (over 1 million kilograms in Canada in 1986) for the control of annual grasses in grain and vegetable crops.¹

Diclofop-methyl is relatively soluble in water (50 mg/L at 22°C) and common organic solvents. It has a very low vapour pressure of 3.4×10^{-8} kPa at 20°C. It is stable at normal pH but is hydrolysed at strong acid or alkaline pH.²

The U.S. Environmental Protection Agency does not consider diclofop-methyl to be a groundwater contaminant; it was therefore not included in the U.S. EPA survey on potential groundwater contaminants.³ Diclofop-methyl ranked very low with respect to potential for groundwater contamination in a similar Agriculture Canada survey.⁴

Exposure

Diclofop-methyl was not detected in 78 municipal drinking water supplies in Manitoba and Alberta.⁵ It was detected in 1% of private farm wells in southern Ontario.⁶ It has occasionally been detected in surface waters, with a maximum concentration of 4 μ g/L recorded in the LaSalle River, Manitoba.⁵

Based on Canadian residue limits for diclofopmethyl⁷ and on Canadian consumption patterns,⁸ the theoretical maximum dietary exposure to diclofopmethyl for an adult Canadian would be 0.0455 mg/d, or 0.00065 mg/kg bw per day. This intake is greater than actual intake, as it assumes that every crop for which diclofop-methyl is registered is treated, and that residues are present in all crops at the maximum residue level of 0.1 µg/g. No actual residue levels in foods are available, as diclofop-methyl was not included in total diet residue surveys in either Canada or the United States.

Analytical Methods and Treatment Technology

Diclofop-methyl is analysed by gas chromatography followed by electron capture detection; the detection limit is about $0.1 \ \mu g/L$,⁹ and the quantitation limit can therefore be expected to be about 0.5 $\mu g/L$.

No information has been found on the effectiveness of current treatment technologies in removing diclofopmethyl from drinking water.

Health Effects

Diclofop-methyl is fairly readily absorbed through the gastrointestinal tract. In rats, 59% of a single oral dose (dose unknown) was excreted after 24 hours. After seven days, 90% was excreted — 70% in faeces and 20% in urine. In the faeces, 20% of the radioactivity from three repeated oral daily doses was excreted as unchanged parent compound.¹⁰ The compound is metabolized to one minor and two major metabolites,¹⁰ with elimination of hydroxylated metabolites as conjugated compounds.²

The acute toxicity of diclofop-methyl is relatively low.² Its principal toxic action is on the liver. A no-observed-adverse-effect level (NOAEL) of 8 µg/g in the diet or 0.2 mg/kg bw per day was established in a 15-month study on dogs, with increased liver weights, increased enzyme levels and centrilobular fatty deposits noted at higher doses (0.63 and 2 mg/kg bw per day).^{10,11} In a two-year study in rats in which the compound was administered at doses of 0, 2, 6.3 or 20 μ g/g in the diet (about 0. 0.1, 0.3, and 1 mg/kg bw per day), some liver enzyme changes (elevations in serum glutamic acid phosphatase and alkaline phosphatase) were noted at 20 µg/g food (equivalent to 1 mg/kg bw per day). Elevation in relative and absolute weights of the ovaries was noted at 2 or 6.3 μ g/g food (about 0.1 and 0.3 mg/kg bw per day, respectively).¹⁰ In a two-year mouse feeding/oncogenicity study in which diclofopmethyl was administered at doses of 0, 2, 6.3 or 20 μ g/g in the diet (about 0, 0.1, 0.3 or 1 mg/kg bw per day), a NOAEL of 2 μ g/g in the diet or approximately

0.1 mg/kg bw per day was established for systemic effects, primarily elevated liver enzyme levels (serum glutamic acid phosphatase and alkaline phosphatase) and liver pathology.¹⁰

There was no evidence of tumorigenicity in the two-year rat study.¹⁰ In the two-year mouse study, a statistically significant increase in hepatocellular benign tumours was noted in male mice, along with some malignant tumours at the highest dose — $20 \ \mu g/g$ in the diet or approximately 1 mg/kg bw per day.^{10,11} These were considered to be in the category of limited evidence for tumorigenicity;¹⁰ no metastases were observed, and tumours were in one sex of a species noted for production of hepatocellular tumours of this type in control as well as experimental animals.

Diclofop-methyl was non-genotoxic in a battery of short-term tests, including Ames mutagenicity tests, an *in vivo* micronucleus test in bone marrow cells of mice orally dosed at 0, 10, 32 or 100 mg/kg bw per day, a gene conversion study in yeast, a dominant lethal test in mice at doses of 0, 10, 32 or 100 mg/kg bw per day and an unscheduled DNA synthesis study in rat hepatocytes *in vitro*.^{10,11}

Diclofop-methyl had no effect on reproduction at any dose up to 5 mg/kg bw per day in a three-generation rat reproduction study. The NOAEL for systemic maternal toxicity (liver weight increases and abnormal pathology) was 30 µg/g in the diet, or 1.5 mg/kg bw per day.¹⁰ No teratological effects were noted in studies on rats and rabbits at doses up to 100 µg/g in the diet, or 5 mg/kg bw per day in the rat and 3 mg/kg bw per day in the rabbit.^{3,10} However, in the rat study, there were indications of embryotoxicity at all dose levels, including the lowest dose of 10 µg/g in the diet or 0.5 mg/kg bw per day.¹⁰

Rationale

Based on evaluations by the Food Directorate of the Department of National Health and Welfare,¹¹ an acceptable daily intake (ADI) for diclofop-methyl is derived as follows:

 $ADI = \frac{0.1 \text{ mg/kg bw per day}}{100} = 0.001 \text{ mg/kg bw per day}$

where:

- 0.1 mg/kg bw per day is the NOAEL for liver enlargement and liver enzyme changes in two-year feeding studies on rats and mice^{10,11}
- 100 is the uncertainty factor assigned by the Food Directorate of the Department of National Health and Welfare (×10 for interspecific variability; ×10 for intraspecific variability).

The maximum acceptable concentration (MAC) for diclofop-methyl in drinking water is derived from the ADI as follows:

 $MAC = \frac{0.001 \text{ mg/kg bw per day} \times 70 \text{ kg} \times 0.20}{1.5 \text{ L/d}} \approx 0.009 \text{ mg/L}$

where:

- 0.001 mg/kg bw per day is the ADI, as derived above
- 70 kg is the average body weight of an adult
- 0.20 is the proportion of daily intake of diclofop-methyl allocated to drinking water (the theoretical maximum food intake is 65% of the ADI)
- 1.5 L/d is the average daily consumption of drinking water for an adult.

References

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